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(19)

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(54) PLASTICS MOULDING

(71) We, GKN SANKEY LIMITED, a British Company of Albert Street Works, Bilston in the County of Stafford, and ARO PLASTICS DEVELOPMENT LIMITED (formerly ARO PLASTIC BUILDING SUPPLIES LIMITED), a British Company of 32 Old Burlington Street, London W.1. do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to methods of and apparatus for, making articles comprising a rigid reinforcement armature encapsulated in thermoplastic material which is moulded about the reinforcement.

In the making of such articles, the plastics material is moulded in a flowable state about the armature at high pressure and it is necessary to hold the armature in position in the mould cavity during moulding to prevent it being displaced by the plastics material as the latter flows.

It has been proposed to hold the armature in position in the mould cavity by projections which extend from the walls of the mould cavity and to withdraw these projections during moulding so that the spaces left by the withdrawal of the projections are filled with plastics material. Thus the armature is held during the initial stages of the moulding by the projections and when the plastics material substantially fills the mould cavity the hydrostatic pressure therein increases the viscosity of the plastics material sufficiently to hold the armature in position during the final stages of moulding.

We have found that in some cases an article produced by this method has witnesses or depressions in its surface where the plastics material has not completely filled the spaces left by the projections as they are withdrawn. We believe that these witnesses or depressions are caused by hardening of the material in contact with, and in the region of, the projections which are normally made of steel.

Where the plastics material is thermoplastic, the mould is cooled to harden the material and the plastics material hardens from the outside, i.e. the mould walls, inwardly and from the inside, i.e. the armature, outwards unless the armature has been preheated in which case the hardening from the inside outwardly will be delayed. If the plastics material solidifies around the free end of a projection as the latter is withdrawn then this can prevent the whole of the space left by the projection being filled by the material with the consequent production of a witness or depression as described.

It is an object of the invention to overcome, or at least reduce the effect of, the above problem.

According to one aspect of the invention we provide a method of moulding thermoplastic material about a rigid reinforcement armature comprising holding the armature in a mould cavity by means of projections which extend from the walls of the cavity and which engage the armature, moulding the thermoplastic material by pressure and while flowable around the armature and projections, abstracting heat from the cavity through the walls of the cavity to harden the thermoplastic material in contact therewith so as to form a skin around a flowable mass of the material while delaying the hardening of the material in contact with the projections until after formation of the skin by controlling the transfer of heat through said projections, withdrawing the projections, while said material is still under pressure, into the cavity walls while the part of said material in the interior of the cavity is sufficiently flowable to be forced to flow under said pressure to

fill the spaces left by withdrawal of the projections and continuing to abstract heat through the walls of the cavity until the whole of the thermoplastic material in the cavity has solidified.

By controlling the heat flow through the projections we prevent the premature hardening of the material adjacent thereto and thus ensure that when the projections are withdrawn the spaces left by their withdrawal are filled with the flowable plastics material.

The transfer of heat through the projections may be abstraction of heat from the cavity but at a slower rate than through the walls. The projections may, as described below, include or be mounted in material which has a lower thermal conductivity than the material of the mould parts.

In an alternative arrangement, heat is transferred into the cavity through the projections until the withdrawal of the projections into the cavity walls.

The moulding is preferably carried out by injection.

According to another aspect of the invention we provide apparatus for moulding thermo-plastic material about a rigid reinforcing armature and comprising relatively movable mould parts arranged to provide a mould cavity; projections movably mounted on one or more of said parts; actuating means for moving the projections between operative positions in which they project into the cavity and can locate the armature therein and inoperative positions in which they are retracted from the cavity; first means in said parts to abstract heat from the cavity by transfer of heat through the walls of the cavity; and second means associated with said projections to control transfer of heat along the projections so that such latter transfer abstracts heat at a rate less than said former transfer or is such as to pass heat into the cavity.

The projections may comprise material which has a lower thermal conductivity than the material of the mould parts, such material comprising said second means. The free end portions of the projections may be formed of, or coated with said material of lower thermal conductivity or each projection may include a sleeve of said material adjacent to, but spaced from, the free end of the projection, the sleeve being located within the cavity when the projection is in its operative position. In another arrangement, each projection may include a core of said material of lower thermal conductivity.

Alternatively, the second means may comprise bushes in the mould parts of material of lower thermal conductivity than the material of the mould parts, the projections being movable in said bushes which are located adjacent to the cavity.

In a still further arrangement, the second means may comprise heaters within the projections, for example electric heaters.

In a still further arrangement, the second means may cause fluid to flow through the projections to heat the projections.

The invention will now be described in detail by way of example with reference to the accompanying drawings in which:—

FIGURE 1 is a cross-sectional view of apparatus embodying the inventoin for carrying out the method of the invention showing the projections in their operative positions.

FIGURE 2 is a view similar to Figure 1 but showing the projections in their inoperative positions;

FIGURES 3, 4 and 5 are sections through the mould cavity of the apparatus of Figure 1 showing three successive stages of moulding; and

FIGURES 6 to 10 are detail sections through the mould cavity of the apparatus of Figures 1 and 2 but showing different forms of means for controlling heat flow along the projections.

Referring now to Figures 1, 2 the apparatus comprises a bottom plate 10 on which are mounted apertured spacer blocks 11, the blocks having apertures 12 to receive hydraulic jacks 13. Secured to the tops of the spacer blocks 11 is a plate 14 having apertures 15 to give passage to the jacks 13.

The mould is formed by a lower mould part 16 having in its upper surface a slot indicated generally at 17 and having a lower, narrower part 18 and an upper wider part 19. This slot partially defines the mould cavity and co-operates with an upper mould part 20 which is received in the upper slot part 19 when the mould is closed, the upper mould part being carried by a top plate 21. The mould cavity is indicated generally at 22. The lower die part is provided with a bore 23 in which is mounted an ejector pin 24 movable by an ejector plate 25 connected to a hydraulic jack, not shown, the ejector plate is guided by pins 26 secured to the plate 14. The mould parts 16 and 20 are formed with passages 16*a* and 20*a* respectively through which cooling water may be passed to harden thermoplastic material which has been injected into the mould cavity.

Mounted in the lower mould part 16 are two sets of projections, two of which are indicated at 27. The projections are slidable in bores 28 in the lower die part from operative positions shown in Figure 1 in which they project into the die cavity 22 to inoperative positions shown in Figure 2

in which the free ends of the projections are flush with the walls of the lower narrower part 18 of the slot 17.

The outer ends of the projections 27 are secured to sliders 29 which are movable horizontally to effect the movement of the projections between their operative and inoperative positions. Each slider 29 has an inclined bore 30 therein in which is slidable a pin 31. The pins 31 are in turn secured to sliding blocks 32 connected to the piston rods 33 of the hydraulic jacks 13, the cylinders of the jacks being secured at 34 to the lower die part 16.

It will be apparent that, starting with the parts in the positions shown in Figure 1, with the projections 27 in their operative positions, if the slidable blocks 32 are moved downwardly by operation of the jacks 13 the sliders 29 will move apart thus moving the projections 27 to their inoperative positions as shown in Figure 2.

The apparatus shown in Figures 1 and 2 is intended for the manufacture of a window frame in which there is a rectangular reinforcing armature embedded in thermoplastic material. It will be appreciated, however, that the invention may be applied to the manufacture of other articles and the mould cavity and armature will be shaped accordingly.

Referring now to Figure 3 an armature 35 is received in the mould cavity 22 and is I-shaped in cross section. The armature thus provides two oppositely directed recesses 36 in which are respectively received the free end portions of the projections 27. The armature is thus located against vertical movement and is prevented from horizontal movement by the dispositions of the projections 27 around the mould cavity. The armature comprises a central part 37 and flanges 38 and 39.

Each projection 27 is made substantially of metal, e.g. steel, but has a reduced portion 40 at its free end and this reduced portion is surrounded by a tip 41 of material which is a poor conductor of heat, for example sintered aluminium oxide. The tip is shaped to fit into a recess 36 to locate the armature and it will be seen that the tip is of sufficient axial length to extend into the lower mould part 16 when the projection is in its operative position as shown in Figure 3 i.e. its position locating the armature 35. The tips 41 are shown as having substantial thickness but they could be formed of a thin coating of sintered aluminium oxide or some other ceramic material on the free end portions of the projections 27.

The method is carried out as follows. The bottom and top plates 10 and 21 respectively are secured to the lower and upper platens of a moulding press. The mould is opened by moving the top plate 21 upwardly. The armature 35 is then placed in the mould cavity. It is preferred that the cavity is in the form of an endless channel which in plan view is rectangular so that a frame member, particularly a window frame, is formed therein by carrying out the method.

The armature 35 is placed in the cavity with the projections 27 retracted to the positions shown in Figure 2 by appropriate operation of the jacks 13. Moreover, the ejector pin 24 has its free end substantially level with the position of the lower surface of the armature thus to support it at the desired level. The jacks 13 are then operated to move the projections 27 inwardly so that they engage the armature and, due to its shape, fully locate it. It will be noted that the longitudinal axes of all the projections lie in a single plane. The armature is held against movement in the plane of the drawing by engagement of the pins with the armature and is held against movement in planes perpendicular to the drawing by the disposition of the pins around the armature.

When the core is located by the pins 27, the ejector pin 30 is retracted to the position shown in Figure 1 in which the upper end of the ejector pin is level with the bottom of the slot 17. The cavity is now closed by introducing the upper die member 20 into the slot and the tool assumes the position shown in Figure 1.

Thermoplastic material is now forced into the die cavity 22 through runners (not shown) and, since the mould parts 16 and 20 are cooled by the circulation of cold water through the water passage 16*a* and 20*a*, the thermoplastic material hardens and forms a skin where the material is in contact with the mould parts. This skin is indicated at 42 in Figure 3. Depending on the temperature of the armature 35, a skin may also form around the armature, such a skin being indicated at 43. If the armature has been preheated before being placed in the mould cavity then the formation of the skin 43 will be delayed. There will be a flowable mass of the plastics material between the skins 42 and 43. Due to the fact that the tips 41 of the projections 27 are made of a material which has a lower thermal conductivity than the material from which the mould parts 16 and 20 are made, the formation of a skin such as 42 around the tips 41 i.e. in the areas 44 in Figure 3 will be delayed since heat cannot flow from the central mass 45 of flowable material through the tips 41 as rapidly as the heat can flow away through the mould parts 16 and 20.

The projections 27 are now withdrawn as shown in Figure 4. Since the tips 41 are

of a material which is not a good conductor of heat a skin does not form across the ends of the projections as the latter are withdrawn so that immediately after withdrawal the position will be as shown in Figure 4 with the skin 42 interrupted across the ends of the projections. The mass 45 of fluid material can now flow into the spaces in the mould cavity vacated by the projections 27, such spaces being cross-hatched in Figure 4 and indicated by the reference numeral 46.

Cooling now continues and as shown in Figure 5 the skin 42 will spread across the ends of the projections as indicated at 47 and gradually the whole mass of material within the mould cavity will harden. It will be appreciated that the mould cavity will be full of material before the projections 27 are withdrawn and therefore further material will be supplied to the cavity through the runners to fill the spaces 46 left by withdrawal of the projections 27. It will be seen that the projections locate the armature 35 during the initial filling of the mould and the armature is held in position by the hydrostatic pressure of the material in the mould during and after the withdrawal of projections 27.

We have found that by delaying the formation of the skin such as 42 around the projections 27 the skin which forms at 47 in Figure 5 has its outer surface level with the adjacent parts of the other surface of the skin 42 and there are substantially no witnesses or depressions formed.

Various arrangements may be used to control the heat flow through the projections. Thus referring first to Figure 6, this shows the use of projections 48 each comprising a metal shank 49 which is provided with an internally threaded bore 50 in its free end. Received in the bore 50 is the threaded shank 51 of a headed stud 52. The shank 51 is of lesser diameter than the shank 49 and the shank 51 of the stud carries a ceramic sleeve 53 between the head of the stud and the end of the shank 49.

Figure 6 shows the projections 48 in their operative positions in which they locate an I-section armature 54 in a die cavity 55 and it will be seen that the ceramic sleeves 53 project into the mould cavity and insulate the plastic material 56 from direct contact with the metal parts of the projections. There will obviously be some heat flow along the projections through the armature 54 and the heads of the studs 51 but the total flow of heat along the projections will be controlled by the sleeves 53 and will be such as to prevent the formation of a skin adjacent to the projections as described in relation to Figures 3 to 5. When the projections are moved to their inoperative positions the heads of the studs will be flush with the walls of the die cavity 55.

Figure 7 shows a further arrangement in which there is a mould cavity 57 containing an I-section armature 58, as described above. In this case the projections 59 are made of metal and are recived in ceramic bushes 60 which are mounted in the walls of the mould cavity 57 so as to be adjacent to the cavity. Heat can flow from the plastics material 61 in the cavity into the projections but is prevented by the bushes 60, for some axial length of the projections, from flowing directly from the projections into the adjacent mould part 62 thus the heat flow along the projections is controlled and the formation of a skin can be controlled as described above in relation to Figures 3 to 5. When the projections are withdrawn to their inoperative positions the ends 63 of the projections are flush with the walls of the mould cavity.

Referring now to Figure 8, this shows a still further arrangement in which there is shown a mould cavity 64 having an armature 65 therein of I-section all as described above. In this case, the projections 66 are made as hollow metal cylinders 67 with solid ends 68 and received within each cylinder 67 is a core 69 of ceramic material which is a poor conductor of heat. It will be seen that in this case heat can flow from the plastics material 70 into the projections but the cross-sectional area available for the ready flow of heat is small due to the provision of the cores 69. This arrangement prevents the formation of a skin in the area adjacent to the projections 66 as described in relation to Figures 3 to 5.

Referring now to Figure 9, this shows an arrangement in which heat is transferred from the projections to the plastic material in the cavity. Referring to this Figure, a mould cavity is indicated at 71 having therein an armature 72 of I-section. Mounted in a mould part 73 are two projections 74 each of which is slidable in a bush 75 of thermally insulating material mounted in the mould part adjacent to the cavity. Recieved in each projection 74, which is in the form of a hollow cylinder with closed end, is an electric heating element indicated at 76. During the initial moulding when the projections are in their operative positions as shown in Figure 9, electricity is supplied to the elements 76 and heat is transmitted through the hollow cylinders forming the projections and which are of metal to retain the plastics material in contact with the projections in a flowable state so as to prevent a skin such as 42 forming in the cavity adjacent to the projections. When the projections are withdrawn to their inoperative positions

with the closed ends flush with the walls of the mould cavity, one of the sliding blocks 32 operates a microswitch 77 through an arm 78 and roller 79 and interrupts the supply of electricity to the heaters in the projections thus enabling the plastics material in contact with the end portions thereof to harden.

Referring now to Figure 10. This shows a mould cavity 80 having an armature 81 of I-section received therein and located by projections 82, in the manner described above. Each projection is in the form of a hollow metal cylinder 83 having a closed end 84. Projecting into the hollow cylinder is a feed pipe 85 for liquid, the feed pipe terminating short of the closed end of the cylinder. The projections are shown in their operative positions in which they locate the armature by engaging in the recesses therein. Hot oil or other liquid is passed along the pipes 85 and flows out of the projections along the annular space between the pipes and the inner surfaces of the metal cylinders. The heat supplied to the projections by the oil or other liquid maintains the plastics material adjacent to the projections in a flowable form with the advantages described in relation to Figures 3 to 5. When the projections are withdrawn to their inoperative positions in which the closed ends 84 are flush with the walls of the mould cavity the supply of oil through the projections is cut off by means of a microswitch operated as described in relation to Figure 9.

It will be seen that the invention provides an effective arrangement for delaying the hardening of thermo plastic material adjacent to the supporting projections before the latter are withdrawn and this enables a good surface finish to be obtained on the moulded article.

WHAT WE CLAIM IS:—

1. A method of moulding thermoplastic material about a rigid reinforcement armature comprising holding the armature in a mould cavity by means of projections which extend from the walls of the cavity and which engage the armature, moulding the thermoplastic material by pressure and while flowable around the armature and projections, abstracting heat from the cavity through the walls of the cavity to harden the thermoplastic material in contact therewith so as to form a skin round a flowable mass of the material while delaying the hardening of the material in contact with the projections until after formation of the skin by controlling the transfer of heat through said projections, withdrawing the projections, while said material is still under pressure, into the cavity walls while the part of said material in the interior of the cavity is sufficiently flowable to be forced to flow under said pressure to fill the spaces left by withdrawal of the projections, and continuing to abstract heat through the walls of the cavity until the whole of the thermoplastic material in the cavity has solidified.

2. A method according to Claim 1 where heat is abstracted from the cavity through said projections at a slower rate than heat is abstracted through the walls.

3. A method according to Claim 1 wherein heat is transferred into the cavity through said projections until the withdrawal of the projections into the cavity walls.

4. A method according to any preceding claim wherein the thermoplastic material is moulded about the armature by injecting moulding.

5. Apparatus for moulding thermoplastic material about a rigid reinforcing armature and comprising relatively movable mould parts arranged to provide a mould cavity; projections movably mounted on one or more of said parts; actuating means for moving the projections between operative positions in which they project into the cavity and can locate the armature therein and inoperative positions in which they are retracted from the cavity; first means in said parts to abstract heat from the cavity by transfer of heat through the walls of the cavity; and second means associated with said projections to control the transfer of heat along the projections so that such latter transfer abstracts heat at a rate less than said former transfer or is such as to pass heat into the cavity.

6. Apparatus according to Claim 5 wherein the projections comprise material which has a lower thermal conductivity than the material of the mould parts and which comprises said second means.

7. Apparatus according to Claim 6 wherein the free end portions of the projections are formed of or coated with said material of lower thermal conductivity.

8. Apparatus according to Claim 6 wherein each projection includes a sleeve of said material of lower thermal conductivity disposed adjacent to, but spaced from, the free end of the projection, said sleeve being located within the cavity when the projection is in its operative position.

9. Apparatus according to Claim 6 wherein each projection includes a core of said material of lower thermal conductivity.

10. Apparatus according to Claim 5 wherein said second means comprises bushes in the mould parts and of material of lower thermal conductivity than the material of the mould parts, the projec-

tions being movable in said bushes which are located adjacent to the cavity.

11. Apparatus according to Claim 5 wherein the second means comprises heaters within the projections.

12. Apparatus according to Claim 5 wherein the second means comprise means for causing fluid flow through the projections to heat the projections.

13. An article comprising a reinforcing armature embedded in thermoplastic material and made by the method according to any of Claims 1 to 4.

14. A method of making an article comprising a reinforcing armature embedded in thermoplastic material substantially as hereinbefore described with reference to the accompanying drawings.

15. Apparatus for making an article comprising a reinforcing armature embedded in thermoplastic material substantially as hereinbefore described with reference to and as shown in Figures 1 to 5 of the accompanying drawings.

16. Apparatus according to Claim 15 but modified as described in relation to and as shown in any one of Figures 6 to 10 of the accompanying drawings.

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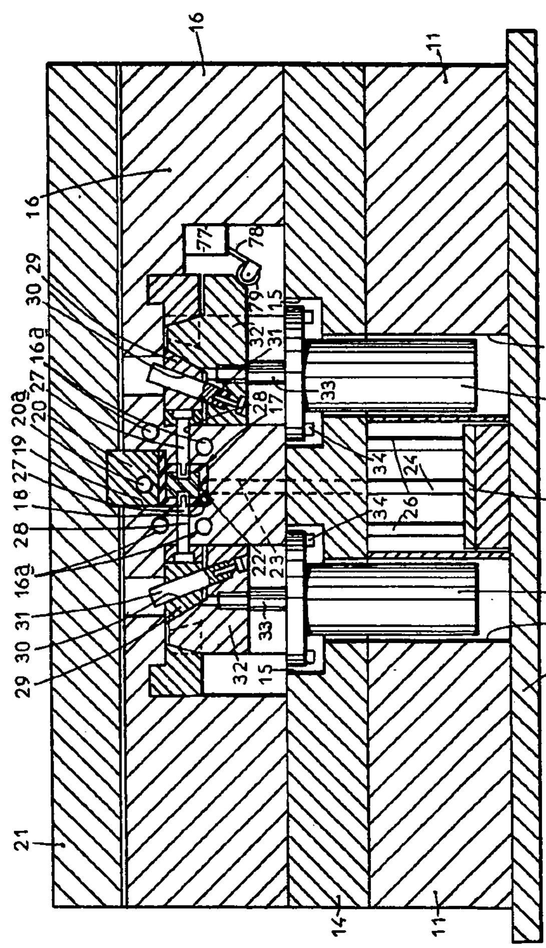

FIG.1.

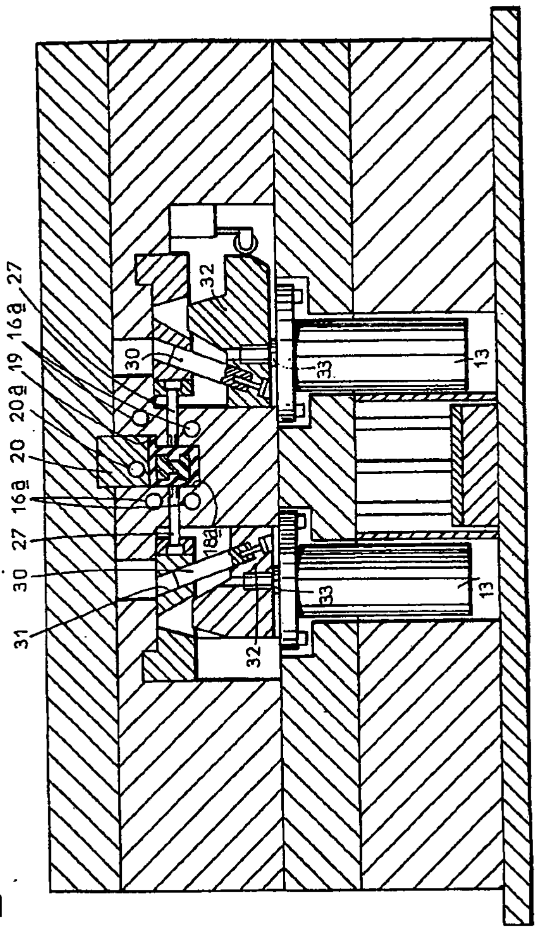

FIG 2

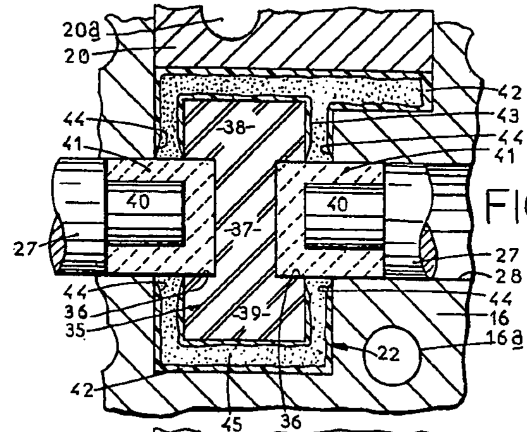

FIG.3.

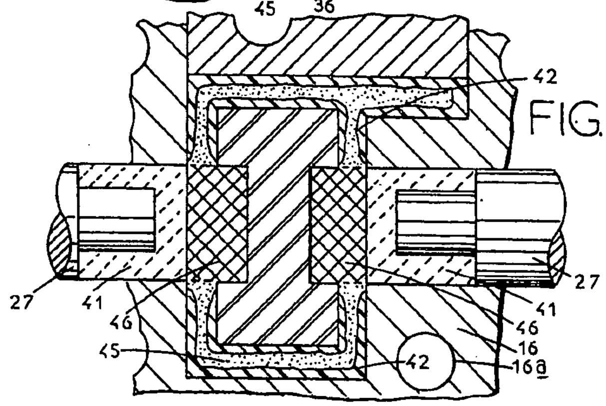

FIG.4.

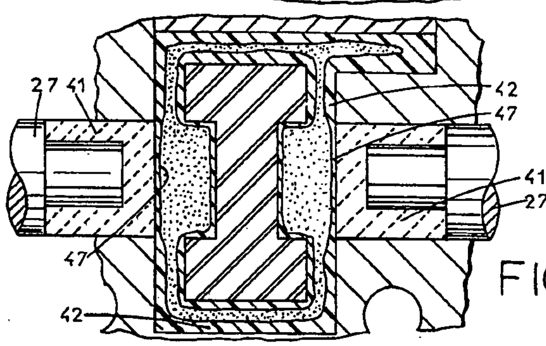

FIG.5.

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Sheet 4

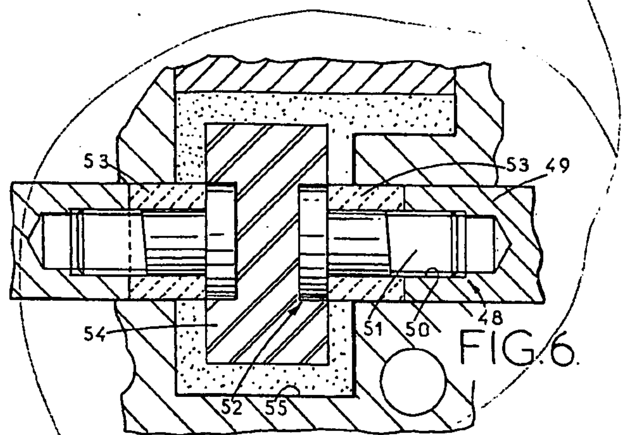

FIG.6.

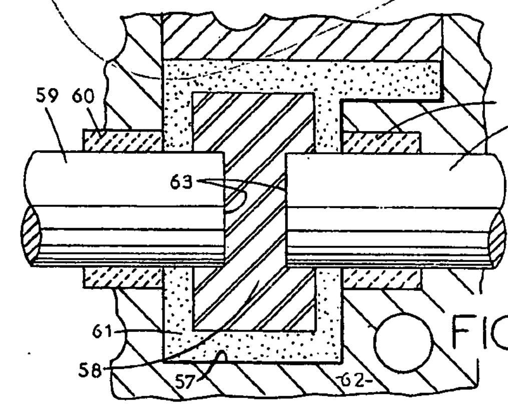

FIG.7

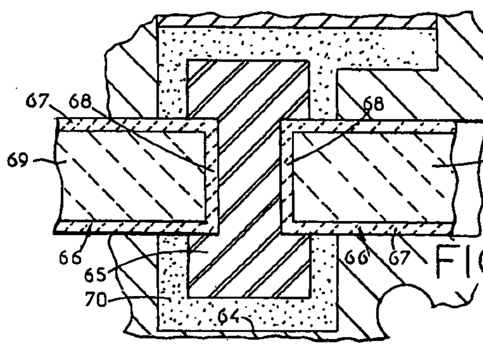

FIG. 8.

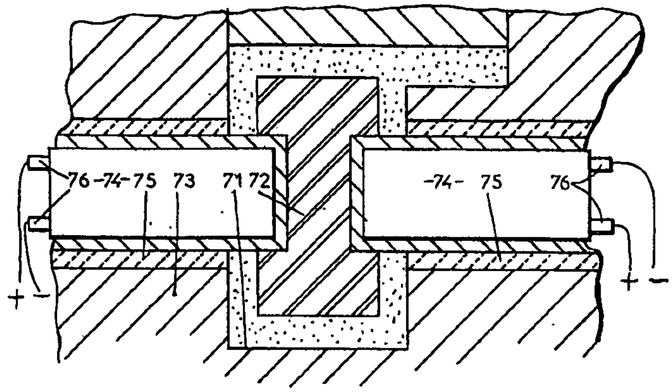

FIG 9.

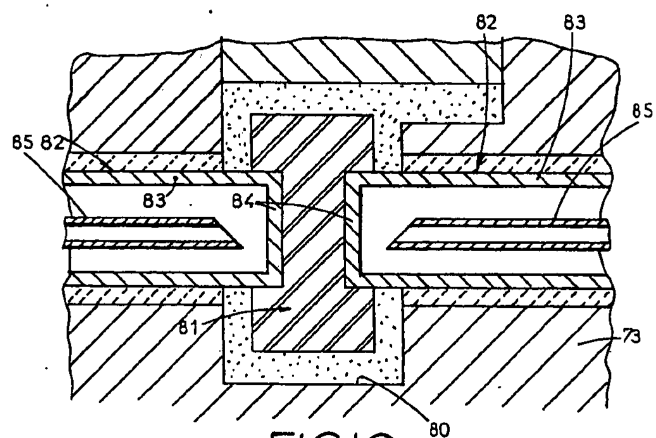

FIG.10.